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Preliminary Summary of USSR Satellite Reports

The material below is based upon a composite of unofficial reports as of October 26, 1957, on the first USSR satellite to be placed in orbit. The reports were gathered from press coverage of Radio Moscow, direct reports to the USNC-IGY, and public reports of various radio and visual tracking activities.

Launching: The official USSR announcement attributed to Radio Moscow on the evening of October 4, 1957, said that the USSR satellite was launched earlier that day at a speed of "about 8000 meters (26,000 ft) per second," at an angle of 65° to the equator and at a maximum height of 560 miles. Scientists in Washington, D. C., were reported to have estimated that the satellite was launched in a northeasterly direction from a point north of the Caspian Sea at approximately 5 pm EDT, October 4.

No details regarding the launching vehicle were made available. However, on October 7 the press quoted Y. A. Pobedonostsev as stating in *Soviet Aviation* that the three-stage carrier reached a speed of 4340–4650 mph before the first stage fell, 1–2 min after launching. Inclining from the vertical about a mile up, it reached an angle of 45° when the second stage fired, boosting the speed to 11,160–12,400 mph before falling. The rocket coasted up to a point about 625 mi from the launching site, where the third stage fired bringing the speed to 18,000 mph. The satellite was then released.

Pravda was quoted in the press as stating that an "extremely accurate and effective system of automatic controls was designed for the rocket. . . ." Pravda also reported that the carrier-rocket and its discarded nose cone were both accompanying the satellite in orbit.

Satellite Characteristics: Radio Moscow's first announcement stated that the USSR satellite is a polished sphere weighing 83.6 kg (over 183 lbs) and 58 cm in diameter (nearly 23 in). Later information released in Moscow revealed that the sphere's four antennae measure from 7 ft 10.5 in to 9 ft 6 in. The antennae were folded back, then sprung into position upon ejection. It was stated that the satellite's visibility was comparable to stars of the fourth to ninth magnitude.

A. A. Blagonravov, a USSR delegate to the recent CSAGI Conference on Rockets and Satellites in Washington, D. C., was quoted in the press as stating that the satellite contained nitrogen for cooling purposes.

Instrumentation: The first announcement by Radio Moscow indicated that there were two transmitters in the satellite, one operating at 20.005 mc and the other at 40.002 mc. The pulse of each signal was 0.3 sec, followed by a pause of similar length during which the other signal was transmitted. (On October 8, the signals were not received for several hours. Later, signals resumed but became continuous.) The announcement stated that "The power of the transmitter

is such as to insure reliable reception by a broad range of amateurs." It was later specified to be one watt. US monitors agreed that the signals were modulated with telemetry data.

Blagonravov informed the CSAGI Conference that temperatures were being reported by the satellite. Later, Pravda was reported to say that temperature and other data were being transmitted. Near the end of the satellite's first week in orbit, Prof. Valerian Krasovsky reportedly stated on Radio Moscow that the atmospheric temperature and density were both indicated to be much lower than had been previously thought. A report the following day added that the satellite "is now being bombarded by micrometeorites." (These were generally thought to consist of debris from the comet Giacobini-Zinner.) It is assumed that this statement was based upon data supplied by appropriate instrumentation in the satellite.

Observations: First US radio reception of the satellite's signals was reported by RCA Communications, Inc., at Riverhead, L.I. The observation occurred at 8:07 pm, EDT, October 4, the day of the launching. At 8:15, the signal was strongest from the south. First reception at the Naval Research Laboratory in Washington, D. C., was at 8:30 pm. (By October 6, six of ten Minitrack stations had been converted from 108 mc—the recommended frequency—to 20 and 40 mc, in order to facilitate radio tracking of the USSR satellite.)

Radio reception was soon general and reports of continuous monitoring were received from Antartic IGY stations, including the South Pole—which is in a position to hear the satellite on virtually every passage —as well as from IGY Drifting Station A, an ice floe about 500 miles from the North Pole.

Reports from the Amundsen-Scott South Pole Station indicated that the satellite's radio signals cut in abruptly but faded out gradually and that there were numerous variations in signal strength, duration, and pulse rate. These variations are believed to be at least partially caused by ionospheric and propagation path conditions, factors that will be studied with the help of tape recordings of the radio signals.

The USSR was reported in the press to be encouraging amateur assistance, offering special cards to hams reporting receipt of the satellite's radio signals.

Radio Moscow announced on October 26 that "the satellite's radio station, having used up its reserve of power," had stopped working. On the same day, the Naval Research Laboratory reported that no signals had been received by Minitrack stations since 5:50 pm EDT, October 25, and that no other information had been relayed to NRL from other radio receiver sources since 7:10 pm EDT, October 25.

Visual observations were more difficult since the satellite's times of passage in the western hemisphere did not, during its first week, coincide with dawn or dusk, when visual fixes might be possible. However, at 6:23 am, EDT, on October 10, James Plato, a member of a New Haven, Conn., Moonwatch Team, sighted the carrier-rocket, then about 600 miles in advance of the satellite. (Much larger, the rocket is easiest of the three orbiting objects to see.) A 5.5-power wide-field telescope was used to find the rocket in the north-west sky at approximately 40° above the horizon.

Press reports indicated that on October 9 all three orbiting objects were detected by a giant radar installation at the Stanford Research Institute at Palo Alto, Calif.

Photographs were reported made by October 11 at Ft. Churchill, Manitoba, in Alberta, and in Stockholm.

In the USSR, it was indicated, 30 telescopes were in use to track the satellite at Leningrad Pulkovo Observatory and a special station had been established at Petrodvorets.

Orbit: Radio Moscow's first announcement stated that the satellite had been placed in an elliptical orbit with an apogee of approximately 560 miles and at an angle in-

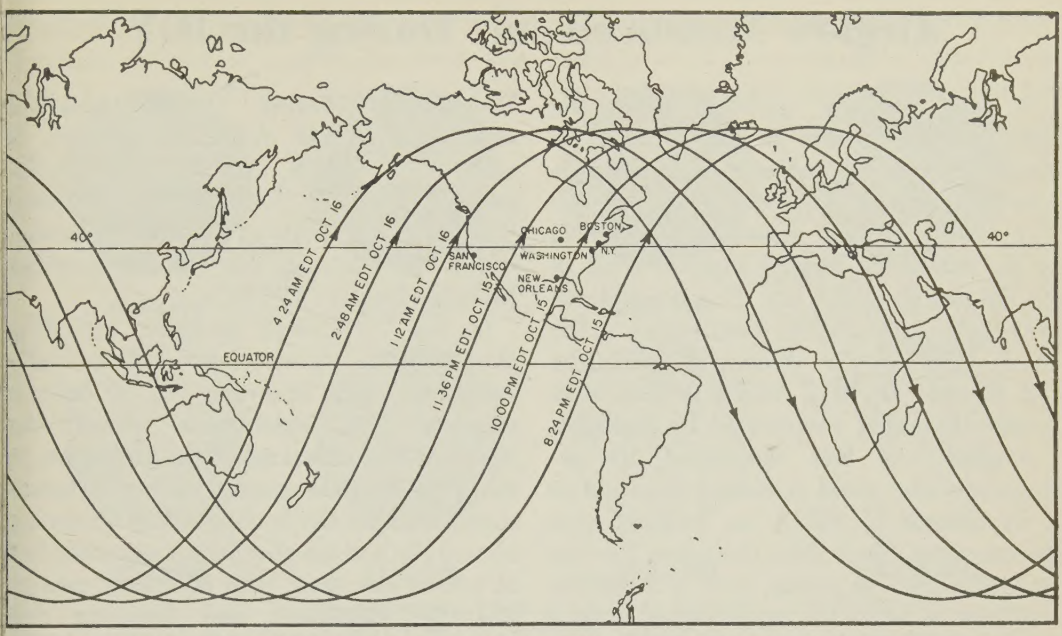

Fig. 1. *Example of Orbit Prediction of USSR Satellite Prepared by U. S. Naval Research Laboratory. (Times computed for 40°N; released October 15, 1957, 11:30 am.)*

clined about 65° to the equatorial plane. The period of rotation was at first described as 95 minutes. The following day, it was stated by Radio Moscow that, "According to precise calculations, the period of its circling the earth lasts 1 hour 36.2 minutes." On October 10, NRL reportedly fixed the orbital period at 96.1 minutes. On several occasions, NRL has described the mean height of the satellite as about 400 mi.

(The path of the USSR satellite has been predicted daily by NRL. The prediction for October 15 appears in Figure 1.)

The press reported that calculations made at Bonn University fixed the satellite's perigee at 156 miles, its apogee at 559 miles and the median height at 357 mi.

On October 9, Pravda was reported to have said of the satellite's orbit that its "altitude changes periodically, reaching a highest point of approximately 1000 km. At present the . . . perihelion is in the northern hemisphere and its apogee in the southern hemisphere."

Precise determinations of the carrier-rocket's orbit were announced by the Smithsonian Astrophysical Observatory on October 11. Apogee was described as 583 miles, perigee as 143 miles. Eccentricity of the orbit was fixed at .05. Precession amounted to a little more than 3° daily. Time for a complete circuit was set at 96.03 minutes. (The rocket was believed to be orbiting faster and generally lower than the satellite itself.) On October 26, Tass was quoted in the press as saying that as of that date the satellite took 95.31 minutes for each orbital period, compared with the original time of 96.2 minutes.

While Blagonravov informed the CSAGI Conference on October 5 that the satellite was designed to orbit for at least two weeks, Radio Moscow stated, on October 10, that "The minute diurnal variation in the [satellite's] time for revolution proves that the satellite will continue encircling the earth for a long time."

Airglow Measurements During the IGY

A faint, usually invisible glow—the night airglow—occurs in the earth's atmosphere, and is a subject of considerable scientific interest and study during the IGY. Although not generally identifiable by the naked eye, airglow supplies much of the light of the night sky. One investigator has roughly estimated its contribution to the visible light—in the absence of moonlight and aurora—at 40%, which is somewhat greater than that contributed by starlight.

Airglow was first discovered by astronomers who noted persistent radiation at a wavelength of 5577Å on long-exposure spectrograms. Since then, this green line has been identified as arising from a forbidden transition in which the oxygen atom emits a quantum of light of wavelength 5577Å while falling to a lower energy state.

Two red emission lines (at 6300Å and 6363Å) have also been discovered in the airglow, and are known to arise from the decay of oxygen atoms from the lower of the green line transition states. The other principal features of the night airglow are the yellow lines of sodium at 5890Å and 5896Å, and the complex system of molecular emissions (chiefly in the infrared) which arise from the hydroxyl radical (OH). These hydroxyl bands are intrinsically so strong that if they were concentrated in the visual region of the spectrum they would be as bright as a prominent aurora and would cause a permanent twilight. Their total intensity is approximately 5000 times that of the oxygen green line in the airglow.

France, Japan, the USSR, India, Australia, and the US are conducting airglow observational programs during the IGY. In addition, Mexico, Peru, and Argentina are collaborating in the American program. The United States stations are situated at Thule, Greenland; College, Alaska; Rapid City, South Dakota; Fritz Peak, Colorado; Sacramento Peak, New Mexico; and, on a cooperative basis, at San Juan, Argentina; Camden, Australia; Huancayo, Peru; and Tonanzintla, Mexico. Overall technical supervision of the American program is under F. E. Roach, Central Radio Propagation Laboratory (CRPL) of the National Bureau of Standards at Boulder, Colorado, and E. R. Manring, Air Force Cambridge Research Center (AFCRC).

In the USNC-IGY program, recording photoelectric photometers automatically sweep the sky according to a definite schedule. The instruments record the principal line emissions of the nightglow in the three separate spectral ranges. Efficient coverage of the sky is obtained by observing around the horizon at different azimuths but at a fixed elevation, with additional sweeps at other elevations, and including one observation at the zenith. Scaling of intensities for a basic station network is accomplished at CRPL through use of a machine which transfers to punch cards readings from the pen and ink records of observed airglow intensities.

The punch cards are then fed into a computer, which applies a correction for light *scattered* into the photometer from the sky. The computer further corrects for the reduction of intensity owing to 'extinction' in the lower atmosphere, and for the apparent increase in intensity for observations taken at increasing angles from the zenith. This is accomplished very rapidly on a digital computer, which prints the corrected absolute intensities for the various locations observed in the sky.

The results are studied in part by plotting maps of constant intensity contours (isophotes) for a given region as deduced from a station's observations (see Fig. 2).

The computer is easily programmed to print numerical intensities correctly positioned in a circular area corresponding to the observed sky so that isophote contours can be quickly sketched in by hand.

The corrections made in reducing the raw airglow data require an estimate of the effective height of emission. Three methods

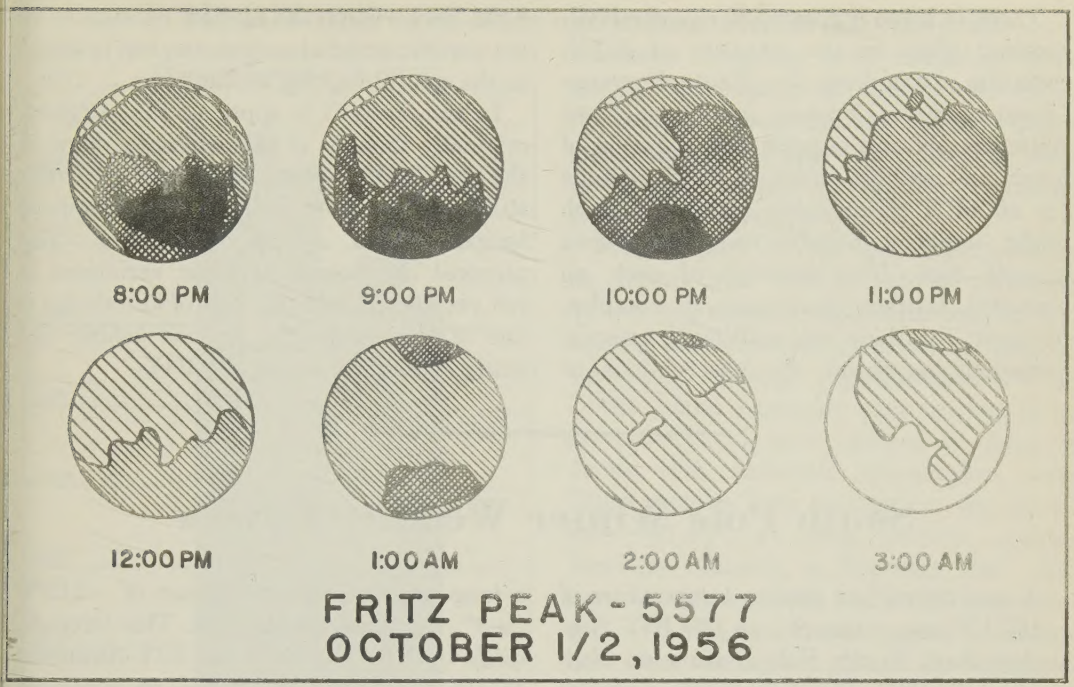

Fig. 2. *Circular Plots of the 5577Å Airglow Intensity in the Entire Sky as Observed at Intervals Throughout the Night of October 1/2, 1956, at Fritz Peak. Outer edge of each circle corresponds to a distance along the earth's surface of about 470 km from the observer, who is in the center of the circle. In preparing these isophote maps, the general increase of intensity toward the horizon has been eliminated.*

have been used: night firing of a rocket through the emitting layer, triangulation between two ground stations, and estimation by analyzing the increase of intensity toward the horizon. Attempts by all three methods lead to a 5577Å line emission height of 100 km, which is consistent with all the data.

The sodium emission layer has been observed at 85 km in a rocket experiment while the OH layer is probably situated at a somewhat lower level (near 70 km). A recent rocket experiment indicates that the red line emission at 6300Å originates above 160 km. This typifies the independent behavior of the oxygen emissions, despite their common transition level.

All airglow observers have noted the intensity variations of the airglow. Often the entire visible sky goes through synchronous variations, showing that the phenomenon is a large-scale one with a dimension of several hundred kilometers. On occasion, however, the various regions of the sky go through quite different variations during a night, as on October 1–2, 1956 (Fig. 2).

The photometric history of the airglow through an entire night is easily followed with the isophote charts mentioned above. The apparent movement of centers of airglow activity throughout the night suggests that the airglow is a dynamic phenomenon of the upper atmosphere. The physical significance of these complex changes is not known, but in a few cases, in which more or less discrete patches have been followed through successive isophote plots, the apparent velocity of motion is about 70 m/sec (150 mph). In general, the size of the large airglow features are of the order of 1000 km, while the temporal variations that occur seem to span several hours. Such motions may, of course, be due to progressive movements of excitation changes in the upper atmosphere, but it is interesting to speculate that they may indicate actual wind motions.

There is some evidence of a latitudinal-seasonal effect in the intensity of 5577Å radiation. Data from the Haute Provence Observatory, in France, and from three American stations suggest that a region of maximum activity exists at 38°N latitude (or at 44°N geomagnetic latitude), which might imply a possible secondary weak auroral zone. The question of such an apparent latitude maximum is complex, however, for there are additional seasonal variations as shown by observations at Fritz Peak. There the airglow is brighter to the north in summer and winter, but brighter to the south in spring and autumn.

In summary, it is apparent that airglow, originally thought of as a quiescent glow in the earth's atmosphere, is shown by current studies to be quite complex with dramatic temporal and spatial variations. The physical significance of these variations is not yet known, and this lack of knowledge is one of the compelling reasons behind the study of airglow during the IGY.

South Pole Winter Weather Review

A new record low surface temperature of −102.1°F was measured at the IGY Amundsen-Scott South Pole Station on September 17, 1957. This eclipses the previous low of −100.4°F, which occurred on May 11 of this year. During the intervening period, spanning from about mid-autumn to late winter in the Antarctic, South Pole temperatures fell below −95°F seventeen times.

The mean temperature at the South Pole throughout the past winter was −73°F; the maximum reached was −26°F. For 90% of the time during the long winter night, the temperature was below −58°F. The high mean wind speed of 16 mph, with peak gusts of about 53 mph, was unexpected; there were only 25 hours of calm weather during the entire winter. Snow storms, with very small crystals, occurred frequently.

The first 17 days of September comprised the coldest period of the winter at the South Pole, with an average temperature of −83°F, and for a four-day period, during which the record low was reached, temperatures never rose above −90°F. By September 25, however, the temperature had risen to −73°F, leading US Weather Bureau meteorologists to surmise that the coldest weather of the current season had passed.

Early in the Antarctic winter just ended, a long-range minimum forecast of −112°F (±3°) was made for the Pole. This forecast, made by Ron Taylor of the IGY Antarctic Weather Central, was based on available climatological data and empirical relationships.

Prior to the occupation of observation stations in Antarctica, it was thought by meteorologists that the mean monthly temperature at inland points would decrease rapidly after the setting of the sun for the winter. Later, it would continue to drop at a slower rate, possibly with some variation, reaching its lowest values at about the time the sun returned in the spring. This temperature regime was expected because it was felt that the strong mean westerly winds at all levels in the high latitudes of the Southern Hemisphere tended to inhibit meridional heat exchange, thus allowing radiational influences to be most effective on the perennially cold, high Antarctic continent.

However, past records from coastal stations show that following the initial rapid drop there actually tends to be a significant rise in mean monthly temperature, followed by another drop to the minimum monthly mean for the year late in the winter. That this unexpected feature of the temperature regime also holds for inland areas seems to be indicated by recent records from the IGY

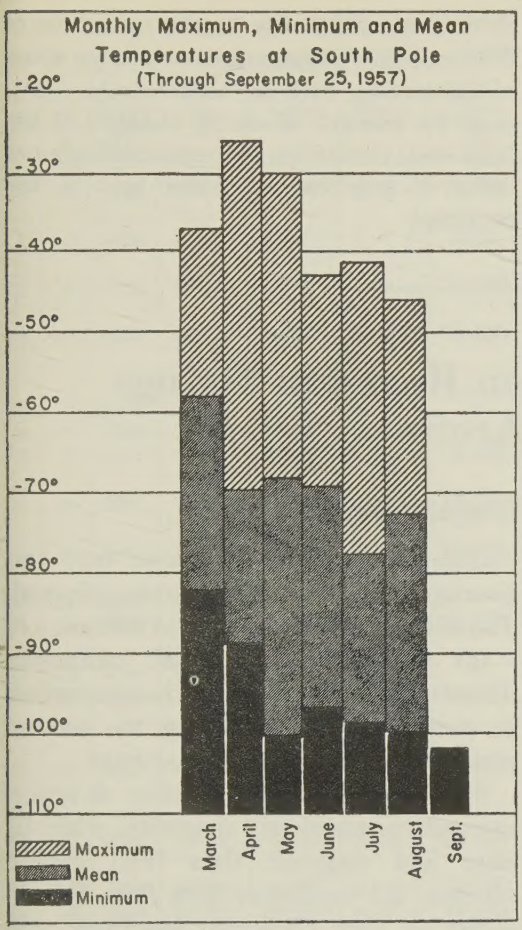

Fig. 3

Byrd and South Pole Stations. Many factors, such as cloudiness, wind velocity, or changes in the large-scale circulation pattern, may be responsible. It is hoped that data accumulated during the past Antarctic winter will provide an explanation.

At the time of the new record-low surface temperature, a pronounced temperature inversion prevailed in the atmosphere over the Pole. Just 30 feet above the surface, the temperature was 27°F higher, and at 1400 feet the temperature was 72°F higher. From about this level, temperatures decreased with altitude.

Such marked vertical temperature inversions are frequently found over polar regions but are accentuated over the South Pole because the dry atmosphere on the high polar plateau (the South Pole Station is at an altitude of 9200 feet above sea level) transmits outgoing heat radiation more readily than sea level atmosphere. Thus, the Antarctic continent, and the snow-laden polar plateau in particular, provide ideal conditions for the formation of vertical temperature inversions.

Prior to the IGY, the lowest temperature on record was −90°F, set in northeast Siberia in February 1933. This reading has already been exceeded a number of times at the US-IGY South Pole Station and at USSR inland Antarctic stations, but it is, nevertheless, of some interest to compare Arctic with Antarctic temperature lows. Other extreme lows recorded in the Arctic are −81.4°F, at Snag Airport, Yukon Territory, Canada, in February 1947—the lowest ever measured in North America—and −86.8°F, at a French station in Greenland, near the highest part of the icecap, in February 1950.

No record low temperatures are likely to be set, however, at the North Pole, where readings below −50°F are improbable. The most important reason for this is that the North Pole is surrounded by a very deep sea. The ice pack that covers most of the surface of the Arctic Ocean averages considerably less than 15 feet in thickness and is able to conduct heat to the atmosphere from the relatively warm and deep ocean below. The Antarctic, conversely, contains land masses far removed from ocean warmth, where great ice thicknesses can build up. A thickness of about 10,000 feet has already been measured at Byrd Station, in West Antarctica, and greater thicknesses are likely in the vast, high interior of East Antarctica.

It is possible that temperatures in the central interior of the Antarctic continent, nearer the "Pole of Inaccessibility," will be found to be even lower than those at the geographic South Pole. This area, where Soviet scientists hope to establish a station, is 4000 to 5000 feet higher than the South Pole and is farther from the sea and its modifying climatological effects. The Soviet Vostok I IGY Station, on the icecap at

72°08′S, 96°34′E, and only about 300 miles inland from the Davis Sea, has already reported a temperature of slightly below −100°F.

Local factors such as cloudiness and wind speed can cause monthly anomalies in temperature at individual stations. However, a significant rise in the mean winter time monthly temperatures over large areas of Antarctica, such as occurred this year, must be brought about by changes of the large-scale circulation patterns, causing a net influx of sensible and latent heat to the continent.

Preliminary Report on Rockoon Firings in the Arctic

During the period August 5–14, 1957, eighteen rockoon (balloon-launched rocket) flights were conducted as part of the US-IGY program by a team of scientists from the State University of Iowa under the direction of Dr. James A. Van Allen. The firings were made from the U.S.S. *Plymouth Rock* in the sea area bounded by Greenland, Labrador, Baffin Island, and Devon Island. These firings, which resulted in the first high-altitude magnetic measurements made within the northern auroral zone, constituted the summer-1957 phase of the IGY rockoon program of the State University of Iowa.

The operations plan called for firing of the rockoons between latitudes 55°N and 76°N. Extensive preparation, carefully coordinated with efforts of the Canadian IGY National Committee, and with essential assistance from the Inter-Service Support Coordinating Group for the US-IGY Rocket Program, culminated in the shipboard assembly of the necessary instruments and equipment.

Scientific equipment was installed aboard the ship during July. Included were eighteen Hawk rockets, thirty 20,000-cubic-foot balloons, a telemeter receiving station, eighteen auroral and cosmic-ray rocket instrumentations, and miscellaneous test equipment. The ship left Norfolk, Virginia, at noon on August 1, 1957, and headed for Thule, Greenland. The return date was August 20.

Scientific Objectives

High-altitude auroral, cosmic ray, and geomagnetic observations were planned. The scientific objectives were as follows:

(a) Investigation of total cosmic-ray intensity through and above the atmosphere in northern latitudes during the present period of maximum sunspot activity.

(b) Correlation of fluctuations of upper-atmosphere cosmic-ray intensity with (i) solar and magnetic data from ground stations, (ii) cosmic-ray data from balloon flights at Fort Churchill, Manitoba, and Minneapolis, Minnesota, and (iii) neutron monitor data at various ground stations.

(c) Investigation of the physical nature, energy, intensity, and latitude distribution of auroral "soft-radiation."

(d) Precise measurement of the absolute scalar magnitude of the total terrestrial magnetic field to altitudes of over 120 km in the auroral zone, using a proton precession magnetometer.

(e) Detection and measurement of atmospheric electrical currents in the auroral zone by the *in situ* measurement of discontinuities in the magnetic-field intensity.

(f) Correlation of high-altitude magnetic data with records from nearby ground magnetic observatories and with related geophysical phenomena.

Table 1. *Arctic Hawk Rockoon Flights*
August 1957

No.	Date (Aug.)	Balloon Release Time (UT)	Lat. N	Long. W	Experiment	Rocket Firing Altitude (ft)	Time of Firing of Rocket (min)	Duration Rocket Flight (sec)	Est. Peak Height (mi)	Results
1	5	1153	55°00′	54°00′	a, b, c	75,000	y + 89	N.K.	N.K.	Very weak telemeter signal
2	5	1658	56°37′	54°25′	d, e, f	N.K.	N.K.	N.K.	N.K.	Telemetering ceased at y + 47 min
3	6	1052	62°16′	56°17′	a, b, c	75,400	y + 81	318.4	72	Excellent data throughout
4	6	1603	63°56′	56°09′	d, e, f	75,000	y + 80	325	73	Good proton precession signals received
5	7	0328	67°20′	57°03′	a, b, c	—	—	—	—	Rocket did not fire
6	7	2204	72°55′	58°31′	d, e, f	—	—	—	—	Rocket did not fire
7	8	0717	75°12′	63°19′	a, b, c	74,000	y + 80	349	82	Good data throughout
8	10	0507	74°18′	63°34′	a, b, c	76,000	y + 82	327.4	73	Excellent data throughout
9	10	2336	72°04′	58°20′	a, b, c	75,000	y + 79	261.8	48	Good data throughout
10	11	0516	70°40′	57°00′	a, b, c	—	—	—	—	Rocket did not fire
11	11	2030	66°56′	54°56′	a, b, c	76,100	y + 88	336	76	Raw field data not yet analyzed
12	12	0748	64°14′	53°57′	a, b, c	—	—	—	—	Rocket did not fire
13	12	1355	63°03′	53°43′	d, e, f	76,100	y + 80	N.K.	N.K.	Telemetering signal ceased after rocket fired
14	13	0158	60°35′	49°16′	a, b, c	N.K.	N.K.	N.K.	N.K.	Electronic apparatus freeze-out at y + 50 min
15	14	0806	59°18′	47°48′	a, b, c	75,400	y + 78	N.K.	N.K.	RF transmitter failure at y + 7 sec
16	14	1350	57°44′	48°09′	d, e, f	74,700	y + 76.5	295	60	Poor data
17	14	2000	56°13′	48°46′	a, b, c	76,100	y + 79	284	55	Good data throughout
18	14	2251	55°40′	48°56′	a, b, c	72,500	y + 79.5	293.1	60	Excellent data throughout

CODE

a. Investigation of total cosmic ray intensity through and above the atmosphere.
b. Correlation of fluctuations of cosmic ray intensity with solar and magnetic data from ground stations.
c. Investigation of physical nature, energy, intensity, and latitude distribution of "auroral soft-radiation."
d. Precise measurement of the absolute scalar magnitude of the total terrestrial magnetic field using a proton precession magnetometer.
e. Detection and measurement of atmospheric electrical currents in the auroral zone.
f. Correlation of results from d and e with records from nearby magnetic observatories at ground stations.

N.K.: Not Known.
y: time of balloon launching.

Preliminary Results

Latitudes of launching ranged from 55°N to 75°N. Good scientific data were obtained up to 22 km during the balloon phase of thirteen of the eighteen flights; on seven of these, good data were obtained throughout the rocket flights as well. Peak rocket altitudes ranged from 77 km to 132 km. A brief report of the results follows:

(a) The total intensity of cosmic rays above the atmosphere at high latitudes is now approximately two-thirds of its value during the 1953–55 period. This intensity is nearly independent of latitude through geo-

magnetic latitudes ranging from 66°N to 86°N.

(b) Five new sets of data on auroral radiation were obtained. Its hardness was measured by a variety of absorbers. Preliminary indications confirm previous interpretations of this X-radiation to be typically of the order of 50 kev. One of these flights is of special interest as it was a night flight to an altitude of 97 km beneath a brilliant aurora that first became visible about ten minutes before the rocket fired. Intense soft radiation was observed by the rocket-borne equipment. A preceding daytime flight (only three hours earlier) showed little or no auroral radiation up to 81 km.

(c) A new magnetic electron spectrometer with a crystal detector was flown for the first time, reaching a maximum altitude of 87 km. No preliminary results are available.

(d) A miniature proton precession magnetometer was test-flown successfully. On a flight to 118 km on August 6, 1957, excellent magnetic intensity data, with an accuracy of five gammas, were obtained at two-second intervals. The data shows a discontinuity in precessional frequency corresponding to 800 gammas at an altitude of about 90 km on the down leg of the trajectory. However, it appears that the rocket spin correction, not yet applied, will account for this discontinuity.

Table 1 presents data on all eighteen rockoon launchings in this series.

The Special World Day Program for the IGY

The World Day Program for the IGY provides for the coordinated intensification of certain observations during periods when major solar-terrestrial effects are predicted. Regular World Days (RWD) and World Meteorological Intervals (WMI) were selected in advance of the IGY, keyed to appropriate phases of the moon, the occurrence of equinox or solstice, and the incidence of meteoric showers. These dates have been indicated in the IGY Calendar of Regular World Days (see *Bulletin*, No. 2, pp. 5–6). In addition, provision was also made for the rapid designation of Special World Intervals (SWI) on occasions of observed increases in solar activity of a character such as will probably be followed by magnetic, ionospheric, auroral, and perhaps cosmic ray disturbances in the earth's atmosphere.

During SWI, ionospheric vertical incidence stations increase their soundings from about every 15 minutes to every 5 minutes. Auroral observers are alerted for increased instrumental observations, and visual observers intensify their watches. Particularly important is the observation of auroras in low latitudes following the greater magnetic storms, and observers in these areas are especially vigilant during the SWI. Some cosmic ray experiments—such as balloon-borne experiments designed to detect cosmic rays of solar origin—are intensified for SWI. Rockets are held in readiness for firing during great magnetic storms, or as soon as possible after the onset of a flare. Solar astronomers also increase their observations during the SWI, particularly for experiments designed for better understanding of the solar eruption mechanisms.

A field station of the National Bureau of Standards, the North Atlantic Radio Warning Service (NARWS) located at Ft. Belvoir, Virginia, about 20 miles from Washington, was designated by the CSAGI as the IGY World Warning Agency (WWA). The World Warning Network is illustrated in Fig. 4.

NARWS had had considerable previous

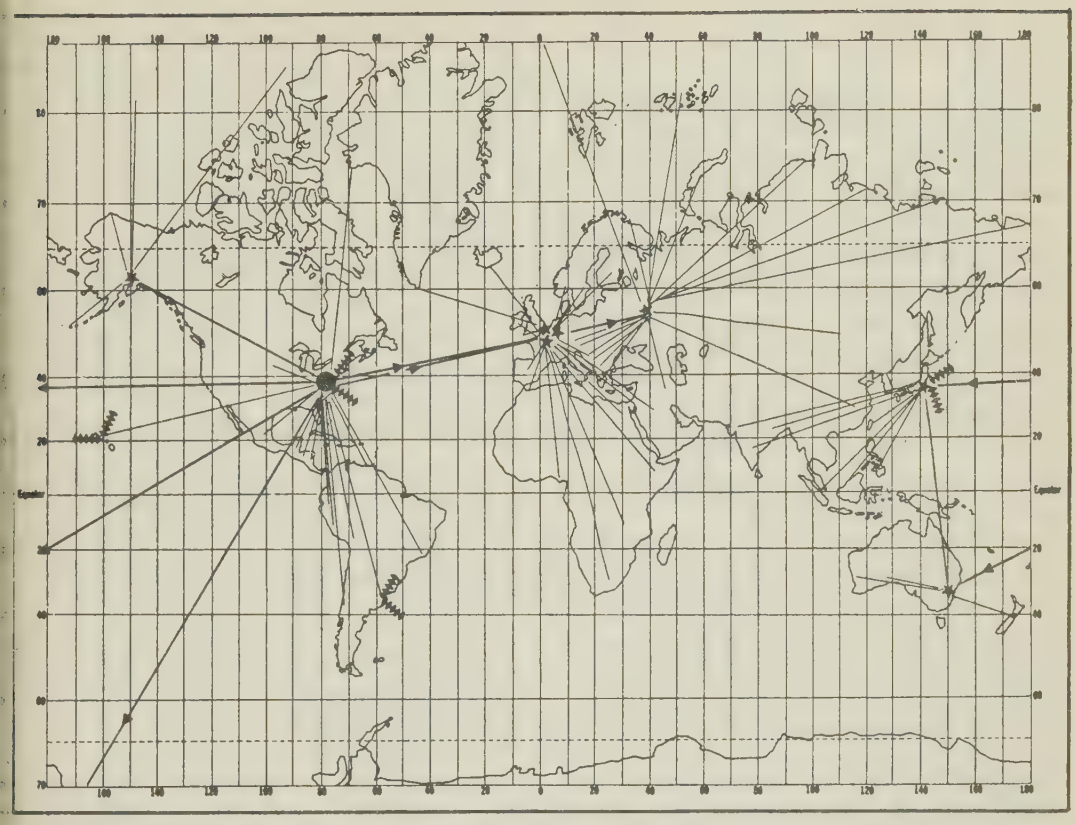

Fig. 4. *IGY World Warning Network. Circle represents World Warning Agency at Fort Belvoir, Va.; stars represent Warning Centers; clustered diamonds represent Radio Warning Stations. Map indicates in schematic fashion how Alert and SWI information is disseminated from the centers.*

experience forecasting ionospheric propagation conditions and was also engaged, with the cooperation of other such services throughout the world, in a study of the prediction of terrestrial solar disturbances.

The WWA examines solar data each day and receives advice from forecasting centers throughout the world concerning the probable solar activity in the coming day. Each day, shortly before 11:00am EST, the WWA must make a decision as to the likelihood of imminent solar disturbances and related terrestrial effects, then issue the daily warning message at 1600 UT (11:00 am EST). Two kinds of messages are sent out on a day-to-day basis by the WWA: Alerts and SWI.

Alerts are called whenever solar activity is unusually high and significant geomagnetic, auroral, ionospheric, or cosmic ray effects are probable. The World Warning Agency utilizes certain criteria for judging the likelihood of impending solar-terrestrial effects, criteria that have been established empirically by past observations of solar astronomers and atmospheric physicists.

For example, an Alert may be declared whenever an unusually active sunspot region is on the solar disk, particularly when it is near the east limb of the sun, four or five days before it rotates towards a position near the center of the disk. The degree of activity of a particular sunspot region is judged by several kinds of observations of the region from the time of its appearance on the limb and during its transit across the disk. At the limb, observation of the intensity of emission of the yellow coronal

line, prominences of the "spray," "loop," and "surge" variety, and the occurrence of limb flares are especially important for judging potential activity of a region.

As the region passes on to the disk, the solar astronomers watch for occurrences of important flares in H-alpha or calcium light, unusual outbursts of radio frequency radiation, high radio flux levels or "noise storms," intense or unusually complex magnetic fields associated with the sunspots, and other similar phenomena. An Alert is usually not declared unless the region has produced a flare of at least importance 2. (The importance factor ranges from subflares to importance 1, 2, and 3.)

During the period of an Alert, an SWI may be declared, usually on eight hours' notice, whenever the probability is high that an active region on the sun will produce an outstanding magnetic storm with associated effects. For example, if a solar flare of importance 3+ is reported by a solar observatory, it is then most likely that at the next opportunity an SWI will be announced by the World Warning Agency.

The WWA receives advice in the early part of the day (all times mentioned are Universal Time or 0° Meridian Time) from observatories located at Moscow, Paris, Nederhorst in the Netherlands, Kokubunji in Japan, Anchorage in Alaska, Prague, Sidney, and Boulder, Colorado. At 1600 UT each day, a message is issued. Alerts commence upon receipt of the message and SWI, if called, commence at 0001 UT the following day; Alerts cease upon receipt of message, SWI at 2359 UT the same day. The messages are as follows:

Alert Starts X/1600Z
Alert Continues
Alert Finishes X/1600Z
SWI Starts Y/0001Z
SWI Continues
SWI Finishes X/2359Z and Alert Continues
SWI Finishes X/2359Z and Alert Finishes X/1600Z
No Alert
Alert Starts X/1600Z and SWI Starts Y/0001Z

(X is the date of the message; Y is the following day's date). These messages are sent to the Regional Warning Centers and Associate Warning Centers at:

Central Direction Netherlands P.T.T.
The Hague, Netherlands

Bureau Ionospherique Francais
Bagneux, France

Fernmeldtechnisches Zentralamt
Darmstadt, Germany

Institute of Terrestrial Magnetism, Ionosphere, and Radio Propagation Moscow, USSR

Radio Research Laboratories
Kokubunji, Tokyo, Japan

Ionospheric Station
Mount Stromlo, Canberra, Australia

North Pacific Radio Warning Service
Anchorage, Alaska

Williams Air Facility
McMurdo Sound, Antarctica

In addition, the messages are also fed into the international meteorological telecommunication circuits. Thus, rapid dissemination of the messages insures that most stations will be alerted in a matter of a few hours. Figure 5 shows the meteorological distribution scheme. Finally, radio messages of Alerts and SWI are broadcast by the National Bureau of Standards' Radio Station WWV in Morse code twice hourly, at four and 34 minutes after the hour, according to the following codes:

AGI—AAAAA State of Alert
AGI—EEEEE No state of Alert
AGI—SSSSS SWI will begin at 0001 UT following day
AGI—(Three long dashes) SWI in progress
AGI—TTTTT SWI terminates 2359 UT same day

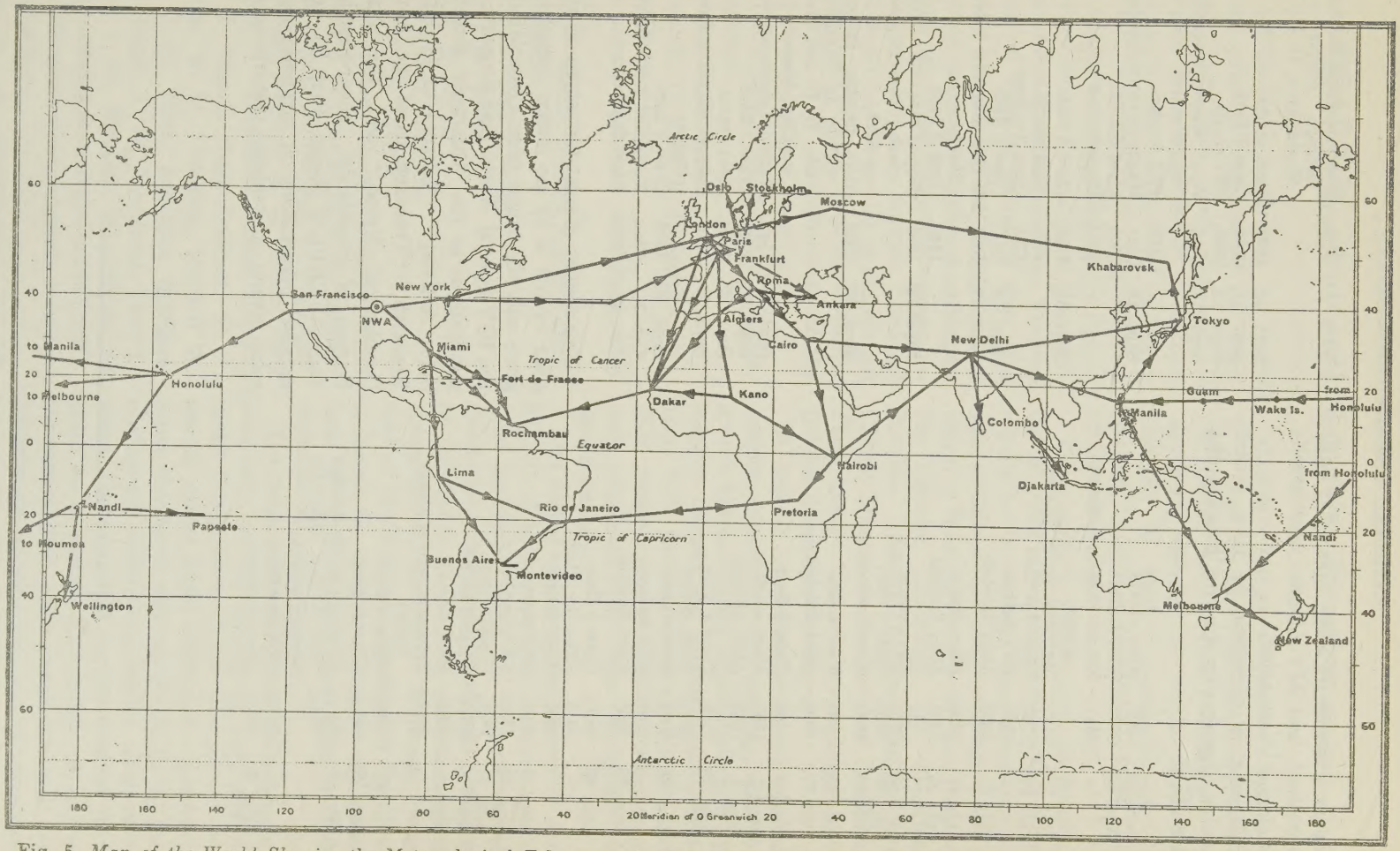

Fig. 5. *Map of the World Showing the Meteorological Telecommunication Channels Over Which SWI Messages Will Be Disseminated During IGY*

Radio Stations WWVH (Hawaii), LOL (Argentina), and JJY (Japan) also broadcast similar information.

Following is a resume of IGY World Warning Messages for the first three months of the IGY:

June 28,	1600,	Alert starts
June 30,	0001,	SWI starts
	04xx,	Severe magnetic storm starts
July 2,	01xx,	Magnetic storm finishes
July 3,	0722,	Class 3+ flare
	2359,	SWI finishes
July 6,	1600,	Alert finishes
July 16,	1600,	Alert starts
July 20,	1600,	Alert finishes
July 21,	1600,	Alert starts
July 23,	1324,	Class 3 flare
July 24,	1600,	Alert finishes
July 25,	1600,	Alert starts
July 27,	1600,	Alert finishes
July 28,	1346,	Class 3 flare
Aug. 2,	1600,	Alert starts
Aug. 7,	1600,	Alert finishes
Aug. 23,	1150,	Class 3 flare
	1600,	Alert starts
Aug. 24,	0001,	SWI starts
	2359,	SWI finishes
Aug. 25,	1600,	Alert finishes
Aug. 28,	0810,	Class 3 flare
	0913,	Class 3+ flare
	1600,	Alert starts
Aug. 29,	0001,	SWI starts
Aug. 30,	2359,	SWI finishes
Aug. 31,	1321,	Class 3 flare
Sept. 1,	9043,	Class 3 flare
Sept. 2,	0001,	SWI starts
	0316,	Severe magnetic storm starts
	1338,	Class 3 flare
Sept. 3,	1412,	Class 3 flare
Sept. 4,	06xx,	Magnetic storm finishes
	1300,	Very severe magnetic storm starts
	2359,	SWI finishes
Sept. 6,	1600,	Alert finishes
Sept. 7,	05xx,	Magnetic storm finishes (aurora visible in Washington, D. C.)
Sept. 9,	1600,	Alert starts
Sept. 11,	0245,	Class 3 flare
Sept. 12,	0001,	SWI starts
Sept. 13,	0046,	Very severe magnetic storm starts
	2359,	SWI finishes
Sept. 15,	06xx,	Magnetic storm finishes
	1600,	Alert finishes
	2040,	Class 3 flare
Sept. 18,	1305,	Class 3 flare
	1600,	Alert starts
	1725,	Class 3+ flare
Sept. 19,	0400,	Class 3 flare
Sept. 21,	1005,	Severe magnetic storm starts
	1340,	Class 3 flare
Sept. 22,	1344,	Second magnetic storm starts, superimposed on first
Sept. 23,	1600,	Alert finishes (aurora visible in Washington, D. C. and Mexico City, Mexico)
Sept. 25,	15xx,	Magnetic storm finishes
Sept. 26,	1907,	Class 3 flare
Sept. 27,	1600,	Alert starts
Sept. 29,	0016,	Severe magnetic storm starts
Sept. 30,	1675,	Class 3 flare
Oct. 1,	05xx,	Magnetic storm finishes
Oct. 2,	1600,	Alert finishes

This resume of solar-terrestrial effects and solar events is by no means complete but gives only the major events associated with the IGY Special World Day program. Such publications as the "Quarterly Bulletin on Solar Activity," "Journal of Geophysical Research," "Transactions of the American Geophysical Union," and the National Bureau of Standards' "Solar-Geophysical Data," (CRPL F Series, Part B), provide detailed information on magnetic activity, solar events, ionospheric disturbances, etc.

CSAGI Rocket and Satellite Conference

An international conference on rocket and earth satellite programs for the International Geophysical Year was held in Washington from September 30 to October 5. This was the first international conference on the IGY to be held in the United States.

The conference was called by the Special Committee for the International Geophysical Year (CSAGI), which asked the National Academy of Sciences to act as host. The conference brought together delegates from the various national committees participating in research rocket and satellite programs. The Chairman was L.V. Berkner, President of ICSU and CSAGI reporter on rockets and satellites. Hugh Odishaw, Executive Director of the USNC-IGY, was Chairman of the General Arrangements Committee.

The following is a list of official delegates who attended:

Australia: K. E. Bullen.

Canada: D. C. Rose, L. F. Smith.

Chile: Enrique Ortiz.

Cuba: Jesus Francisco de Albear, Luis Larragoiti.

Ecuador: Neptali Bonifaz, Carlos Castro, Alfredo Schmitt.

France: Lt. Gen. J. Guerin.

India: A. P. Mitra.

Iran: H. K. Afshar.

Japan: Takeo Hatanaka.

Peru: Jorge A. Broggi.

United Kingdom: Alastair Anthony, W. T. Blackband, J. G. Davies, H. S. W. Massey.

United States: W. Berning, G. M. Clemence, Michael Ference, N. C. Gerson, John P. Hagen, J. Hanessian, Joseph Kaplan, Homer E. Newell, Hugh Odishaw, W. J. O'Sullivan, W. H. Pickering, Richard W. Porter, J. G. Reid, Athelstan Spilhaus, W. G. Stroud, J. W. Townsend, Fred L. Whipple, P. H. Wyckoff. In addition, 49 scientists and engineers, active in the USNC-IGY satellite and rocket programs, served as delegates-at-large.

USSR: A. A. Blagonravov, A. M. Kasatkin, Sergei M. Poloskov.

CSAGI: Sydney Chapman, President; L. V. Berkner, Vice President and Reporter for Rocket and Satellite Programs; V. V. Beloussov, Member; M. Nicolet, Secretary-General; A. Day, Coordinator; A. H. Shapley, Reporter for World Days and Communications.

The conference opened at 10 am, September 30, with a plenary session, when status reports by the various national delegations were presented. The conference then divided into four Working Groups: Rocketry; Satellite Vehicles, Launching, and Tracking; Satellite Internal Instrumentation; and CSAGI Manual on Rockets and Satellites. These groups met at various times from October 1 through October 4.

A number of special papers on satellite vehicles, launching, and tracking, satellite ground-based scientific experiments, orbiting satellite devices and internal instrumentation, IGY rocketry program results, and IGY rocket research vehicles, techniques, and instrumentation were presented at special sessions.

The closing session of the conference was held at 10:30 am October 5. There was a brief description by A. A. Blagonravov of the Soviet satellite which had been launched on October 4. Conference resolutions were then presented. Dr. Detlev W. Bronk, President of the National Academy of Sciences, addressed the delegates, stressing the broad base of international cooperation which underlies the IGY program.

The resolutions, which were adopted unanimously, call for the prompt reporting of rocket firing data to World Data Centers on special rocket flight information summary forms developed and agreed on during the conference, within two weeks after each firing. The conference further resolved that there be a mutual interchange of rocket instrumentation and equipment and an interchange of personnel among countries participating in the IGY rocket program. The final resolution concerning rockets calls

for simultaneous launching of rockets on June 18, 1958, during a World Meteorological Interval.

Resolutions concerning the earth satellite program emphasized the need for additional visual and optical stations for satellite tracking, especially in higher latitudes, and for additional radio receiving stations providing tracking and telemetry reception at 108 mc/sec, 20 mc/sec, and 40 mc/sec.

The conference noted the possibility of using the facilities of existing ionospheric stations to receive satellite telemetered signals as well as the possibility of gaining interesting ionospheric data by means of radio amateur and volunteer observations of the Soviet satellite.

To implement the recommendation that additional telemetry stations be set up by research institutions and amateur radio groups, the conference recommended that both the US and the USSR provide advance data as to the forms of signals which they would transmit and that they also prepare articles about their systems to be disseminated to amateur radio groups.

The conference also recommended that the US and the USSR make arrangements for the rapid dissemination of information on satellite orbits and stated that it considered the exchange of publications, technical data, and scientific instruments pertaining to satellites highly desirable.

The need for coordination in content of transmitted positional and orbital data and consistency of basic constants and standards used in computation was also noted; the conference recommended that interested national committees meet in the near future to discuss these matters.

The final group of resolutions concerned the need for additional coordination on those items that could not be settled at the conference and recommended that special attention be given to the need for continued programs of scientific research utilizing instrumented rockets and earth satellites after the close of the IGY. To this end the conference recommended that countries undertaking such plans make information concerning their plans available as soon as possible.

A definitive survey, with maps, photographs, and diagrams, of the USNC-IGY Antarctic Program is available from the National Academy of Sciences, National Research Council, 2101 Constitution Ave., N. W., Washington 25 D. C., for $1.00 (Publication 553).

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